CLAIMS

1. A positive electrode active material represented by the composition formula: $Li_{2\pm\alpha}[Me]_4O_{8-x}$, wherein $0 \leqq \alpha < 0.4$, $0 \leqq x < 2$, and Me is a transition metal containing Mn and at least one selected from the group consisting of Ni, Cr, Fe, Co and Cu, said active material exhibiting topotactic two-phase reactions during charge and discharge.

2. The positive electrode active material in accordance with claim 1, characterized in that the phase of the transition metal has a 2×2 superlattice.

3. The positive electrode active material in accordance with claim 1, characterized in that the ratio between Mn and other transition metal is substantially 3:1.

4. The positive electrode active material in accordance with claim 1, characterized in that said positive electrode active material has a spinel-framework-structure and the Li and/or Me exist in the 16(c) site in the space group Fd3m.

5. The positive electrode active material in accordance with claim 1, characterized in that said positive electrode active material has charge/discharge curves with a potential difference of 0.2 to 0.8 V.

6. The positive electrode active material in accordance with claim 1, characterized in that said positive electrode active material has a lattice constant attributed to

a cubic crystal of not greater than 8.3 Å.

7. The positive electrode active material in accordance with claim 1, comprising a mixture of crystal particles with a particle size of 0.1 to 8 μm and secondary particles of said crystal particles with a particle size of 2 to 30 μm.

8. A method for producing a positive electrode active material comprising:

(1) a step of mixing Mn and a compound containing at least one selected from the group consisting of Ni, Cr, Fe, Co and Cu to give a raw material mixture; or a step of synthesizing a eutectic compound containing a Mn compound and at least one selected from the group consisting of Ni, Cr, Fe, Co and Cu;

(2) a step of mixing said raw material mixture or eutectic compound with a lithium compound; and

(3) a step of subjecting the compound obtained by said step (2) to a first baking at a temperature of not less than 600℃,

whereby a positive electrode active material represented by the formula: $Li_{2\pm\alpha}[Me]_4O_{8-x}$, where $0 \leqq \alpha < 0.4$, $0 \leqq x < 2$, and Me is a transition metal containing Mn and at least one selected from the group consisting of Ni, Cr, Fe, Co and Cu, said active material exhibiting topotactic two-phase reactions during charge and discharge is obtained.

9. The method for producing a positive electrode

active material in accordance with claim 8, characterized in that said first baking is performed at a temperature of not less than 900℃.

10. The method for producing a positive electrode active material in accordance with claim 8, characterized in that said method further comprises a step of performing a second baking at a temperature lower than that of said first baking after said first baking.

11. The method for producing a positive electrode active material in accordance with claim 10, characterized in that said second baking is performed at a temperature of 350 to 950℃.

12. The method for producing a positive electrode active material in accordance with claim 10, characterized in that said second baking is performed at a temperature of 650 to 850℃.

13. The method for producing a positive electrode active material in accordance with claim 8, characterized in that said method further comprises a step of rapidly cooling said positive electrode active material after said first baking and/or said second baking.

14. The method for producing a positive electrode active material in accordance with claim 13, characterized in that said rapid cooling is performed at a temperature decrease rate of not less than 4.5 ℃/min.

15. The method for producing a positive electrode

active material in accordance with claim 13, characterized in that said rapid cooling is performed at a temperature decrease rate of not less than 10 ℃/min.

16. The method for producing a positive electrode active material in accordance with claim 14, characterized in that said rapid cooling is performed until the temperature reaches room temperature.

17. A non-aqueous electrolyte secondary battery comprising; a positive electrode containing the positive electrode active material in accordance with claim 1; a negative electrode containing a titanium oxide; and a non-aqueous electrolyte and a separator,

characterized in that said battery has a usable charging/discharging region of 2.5 to 3.5 V and a practical average voltage of 3V level.

18. The non-aqueous electrolyte secondary battery in accordance with claim 17, characterized in that said titanium oxide has a spinel structure.

19. The non-aqueous electrolyte secondary battery in accordance with claim 17, characterized in that said titanium oxide is $Li_4Ti_5O_{12}$.

20. The non-aqueous electrolyte secondary battery in accordance with claim 17, characterized in that said battery has an operating discharge curve with a potential difference of 0.2 to 0.8 V.

21. The non-aqueous electrolyte secondary battery in

accordance with claim 17, characterized in that said positive and negative electrodes have a current collector made of aluminum or an aluminum alloy.

22. The non-aqueous electrolyte secondary battery in accordance with claim 17, characterized in that said non-aqueous electrolyte comprises at least one selected from the group consisting of propylene carbonate, γ-butyrolactone, γ-valerolactone, methyl diglyme, sulfolane, trimethyl phosphate triethyl phosphate and methoxymethylethyl carbonate.

23. The non-aqueous electrolyte secondary battery in accordance with claim 17, characterized in that said separator is made of non-woven fabric.

24. The non-aqueous electrolyte secondary battery in accordance with claim 23, characterized in that said non-woven fabric comprises at least one selected from the group consisting of polyethylene, polypropylene and polybutylene terephthalate.

25. The non-aqueous electrolyte secondary battery in accordance with claim 17, characterized in that the weight ratio of said negative electrode active material to said positive electrode active material is not less than 0.5 and not greater than 1.2.

ABSTRACT

In order to provide a 3V level non-aqueous electrolyte secondary battery with a flat voltage and excellent cycle life at a high rate with low cost, the present invention provides a positive electrode represented by the formula: $Li_{2\pm\alpha}[Me]_4O_{8-x}$, wherein $0 \leqq \alpha < 0.4$, $0 \leqq x < 2$, and Me is a transition metal containing Mn and at least one selected from the group consisting of Ni, Cr, Fe, Co and Cu, said active material exhibiting topotactic two-phase reactions during charge and discharge.